

REMARKS**I. Status of the Claims**

Claims 2, 17-74, 76-108, 110 and 112-113 are currently pending. Claims 1, 3-16, 75, 109 and 111 were previously cancelled.

Claim 17 has been amended to change its dependency from cancelled claim 109 to claim 82.

In the Office Action of June 14, 2010, the Examiner:

- asserted that claim 95 and 96 are rejected on the grounds of *res judicata*;
- rejected claim 17 under 35 USC 112, second paragraph, as being indefinite;
- rejected claims 79, 81, 86, 88 and 97 under 35 USC 103(a) as being unpatentable over Dempsey et al. (US 4,277,984) in view of Nagata et al. (US 4,913,792) and any of Vanderborgh et al. (US 4,804,592), Uchida et al. (US 5,474,857) and/or Grot et al. (US 5,330,860);
- rejected claims 17, 79-101, 103-106, 108, 110 and 112-113 under 35 USC 103(a) as being unpatentable over Tomantschger et al. (US 5,173,166) in view of Dempsey and any of Vanderborgh, Uchida and/or Grot;
- rejected claims 17, 80, 82, 84, 87, 89, 91, 92, 95, 96, 98-101, 103, 104, 108, 110 and 112-113 under 35 USC 103(a) as being unpatentable over Dempsey in view of any of Vanderborgh, Uchida and/or Grot;
- rejected claims 83, 85, 90, 93 and 94 under 35 USC 103(a) as being unpatentable over Dempsey in view of any of Vanderborgh, Uchida and/or Grot and further in view of Nagata;
- rejected claim 102 under 35 USC 103(a) as being unpatentable over Dempsey in view of any of Vanderborgh, Uchida and/or Grot and further in view of Tomantschger (US 5,302,274);
- rejected claim 102 under 35 USC 103(a) as being unpatentable over Tomantschger '166 in view of Dempsey and any of Vanderborgh, Uchida and/or Grot and further in view of Tomantschger '274;

- rejected claims 105 and 106 under 35 USC 103(a) as being unpatentable over Dempsey in view of any of Vanderborgh, Uchida and/or Grot and further in view of La Conti (US 4,820,386);
- rejected claim 107 under 35 USC 103(a) as being unpatentable over Dempsey in view of any of Vanderborgh, Uchida and/or Grot and further in view of Razaq (US 5,322,602);
- rejected claim 107 under 35 USC 103(a) as being unpatentable over Tomantschger '166 in view of Dempsey and any of Vanderborgh, Uchida and/or Grot and further in view of Razaq; and
- indicated that claims 2 and 18-29 would be allowable if rewritten as independent claims and that claims 30-74 and 76-78 are allowed.

## II. Summary of Applicants' Main Points

For a gas sensor to be operative, the catalyst within the electrodes must be exposed to the gas being sensed. If an electrode becomes flooded (*i.e.*, if liquid penetrates into the pores of the electrode) gas to be sensed will be blocked by the liquid and will not be able to gain access to the catalyst within the electrodes. Thus, a gas sensor with flooded electrodes would be inoperative. Electrodes may be manufactured that are hydrophobic, *i.e.*, they repel water, but let gas permeate into the pores.

Dempsey discloses a gas sensor having electrodes that are immersed in water. Dempsey discloses that its electrodes are hydrophobic—as they must be, in order to repel the surrounding water and preclude flooding. Tomantschger discloses a gas sensor wherein its electrodes are exposed to liquid electrolyte or to liquid water. Tomantschger discloses that its electrodes are hydrophobic—as they must be, in order to repel the liquid electrolyte/water and preclude flooding. The Examiner proposes to replace either Dempsey's or Tomantschger's necessarily hydrophobic electrodes with hydrophilic electrodes as taught by Grot (when informed by Surampudi). Grot's hydrophilic electrodes, in Dempsey's or Tomantschger's gas sensors, would become flooded and would render these devices inoperable.

(a) In the present application, every rejected claim is subject to a Section 103 rejection that relies, at least in part, on the combination of Dempsey with Uchida, Vanderborgh and/or Grot. Dempsey discloses a gas sensor having hydrophobic electrodes on either side of a Nafion® membrane, wherein the membrane is hydrated with liquid water. The claims require electrodes having a “proton-electron mixed conductive material having 10-50 wt% of a proton conductor material and 50-90 wt% of a first and second electrical conductor material.” The Examiner asserts that each of Uchida, Vanderborgh and Grot disclose this required electrode composition, and further that it is proper to replace Dempsey’s hydrophobic electrodes with the electrodes disclosed in Uchida, Vanderborgh and/or Grot. Applicants submit that this combination is improper for the following reasons:

First, Uchida and Vanderborgh fail to disclose the claimed composition of the “proton-electron mixed conductive material” for the electrodes. Thus, their disclosures are not particularly relevant.

Second, it is not proper to combine Dempsey with Grot (and/or *arguendo* with Uchida or Vanderborgh), as the combination would render Dempsey inoperative. The relied-upon electrodes of Grot are hydrophilic. Dempsey repeatedly and expressly discloses hydrophobic electrodes and, in fact, Dempsey’s electrodes must be hydrophobic to keep the surrounding liquid water from flooding them. Flooded electrodes would render Dempsey’s sensor inoperable. In other words, replacing Dempsey’s hydrophobic electrodes with the hydrophilic electrodes of Grot would allow the liquid water to flood the electrodes, thereby rendering Dempsey inoperative.

And third, contrary to the Examiner’s most recent assertions, none of the cited references teach or suggest that a hydrophilic electrode, such as disclosed by Grot, may be converted to a hydrophobic electrode by the addition of a coating or other water repellent treatment (or by any other means) such that the coated/treated hydrophilic electrode would not flood when immersed in or directly exposed to liquid water.

(b) Certain of the claims are directed to gas sensors having only two electrodes. The Examiner asserts that Tomantschger ‘166 or Nagata in combination with Dempsey and with Uchida, Vanderborgh and/or Grot render these “two electrode” claims unpatentable. Dempsey discloses a gas sensor having three electrodes—a sensing electrode and a counter

electrode plus a reference electrode. Dempsey's reference electrode forms the linchpin for Dempsey's potentiostated circuitry, which is used to maintain the sensing electrode above a certain potential and thereby to ensure temperature invariant current characteristics at a zero-air condition (see title). Thus, Dempsey teaches away from a two electrode device, and certainly, cannot fairly be modified by eliminating its reference electrode. Each of Tomantschger '166 and Nagata disclose that three electrode sensors can be converted to two electrode sensors by eliminating the reference electrode. However, eliminating Dempsey's reference electrode to convert Dempsey's three electrode sensor to a two electrode sensor would destroy Dempsey's potentiostated circuitry. If one were to eliminate the reference electrode from Dempsey, as the Examiner urges: (1) Dempsey's principle of operation would be changed; and (2) Dempsey's gas sensor would be rendered unsatisfactory for its intended purpose. Both of these are impermissible.

(c) Finally, the Examiner's invocation of *res judicata* to reject certain claims is improper. Rather, the new record, including new evidence, placed before the Examiner in this prosecution, present new issues that must be substantively addressed by the Examiner.

### **III. Examiner's Response to Arguments in June 14, 2010 Office Action**

In the June 14, 2010 Office Action's Response to Arguments section (pp. 20-30), the Examiner raised certain points regarding the prior art (Dempsey, Uchida, Vanderborgh, Grot, Surampudi, Cisar, LaConti, Tomantschger, Nagata, etc.) and certain combinations thereof. Applicants address these points in paragraphs (a) through (j) below.

As a preliminary matter, Applicants note that in the Response to Arguments section of the June 14, 2010 Office Action, the Examiner several times refers to Applicants' own disclosure either in the instant application or in Applicants' co-pending application (10/621,637) for his rationale for combining references or for what the cited references teach (see e.g., items 62, 67, 69). Applicants' own disclosures are not "prior art." Thus, Applicants respectfully submit that it is improper for the Examiner to rely on the teachings of the instant application to make or bolster his arguments as to the teachings of the prior art references or the rationale for combining references. Furthermore, Applicants submit that their teachings are not inconsistent with their arguments as to what the prior art

references taught to persons of ordinary skill in the art at the time the invention was made or whether a person of ordinary skill in the art at the time the invention was made would have a rationale to combine the prior art teachings.

- (a) **Uchida fails to disclose “a proton-electron mixed conductive material having 10-50 wt% of a proton conductor material and 50-90 wt% of a first and a second electrical conductor material.”**

The Examiner argues in the June 14, 2010 Office Action, paragraph 63, that the claimed “proton-electron mixed conductive material” doesn’t require that the material be mixed, only that the material is “a material possessing both proton and electron conduction.” The Examiner further asserts that this recitation reads on Uchida’s use of a separate coating step to form a separate layer of Nafion® (a proton conductor) over an electron conductive catalyst layer, because (1) the claims don’t require that the material is mixed, and thus, separate layers are encompassed by the claims; or alternatively, (2) the Nafion® coating is not a separate layer because the catalyst layer is porous and the Nafion® coating is integrated into the electron conductive material.

As to point (1), the claims do require that the proton-electron mixed conductive material is a single mixed material, not layers. “During examination, ‘claims . . . are to be given their broadest reasonable interpretation consistent with the specification, and . . . claim language should be read in light of the specification as it would be interpreted by one of ordinary skill in the art.’” (See *Ex parte Jenkins*, BPAI, Appeal 2009005028 (September 2009)). In this case, the specification explicitly discloses that the proton-electron mixed conductive material has the proton conductor material and the electron conductor material mixed together. For example, the specification discloses that the protonic conductor and the electronic conductors are mixed together as a wet electrode mixture which is then dispensed onto the surface of the membrane and dried (see col. 15, line 26 to col. 16, line 17). Thus, the specification discloses that the proton-electron mixed conductive material is formed as a “mixture,” *i.e.*, a single mixed material, not layers of unmixed materials. Further, FIG. 7 of the specification discloses a mixed material with electronic conductive phase material 82 and a protonic conductive phase material 84 dispersed and mixed

throughout, i.e., FIG. 7 shows a mixed proton-electron conductive material as a single mixed material (see FIG. 7; col. 12, lines 63-64; and col. 13, lines 29-30).

As to point (2), applying a Nafion® coating onto a previously formed catalyst layer does not form a “proton-electron mixed conductive material,” even if the catalyst layer has a surface porosity. As an analogy, applying marmalade to an English muffin does not create a new material no matter that the marmalade gets into the nooks and crannies of the muffin—it’s still marmalade on a muffin. And in fact, as discussed in more detail below, Uchida recognizes that applying a Nafion® coating onto a catalyst layer (the comparative example, cell X, disclosed at col. 7, line 55 to col. 8, line 7) is different than (and inferior to) forming a mixed Nafion®/catalyst material (Uchida’s inventive examples, cells A, B, C, D, E, F, and A’). Although the Examiner refers to Figs. 2 and 3 of Uchida, these illustrate Uchida’s inventive examples, not the comparative example of the Nafion®-coated cell X.

Thus, Applicants maintain, as further discussed below, that Uchida does not disclose the claimed electrode composition and is, thus, not relevant.

- (b) **Vanderburgh fails to disclose “a proton-electron mixed conductive material having 10-50 wt% of a proton conductor material and 50-90 wt% of a first and a second electrical conductor material.”**

The Examiner argues in the June 14, 2010 Office Action, paragraph 64, that “if a mixture of two different materials can be construed as being a singular “material” *as would be necessary for interpreting the present claims in view of the specification*, it is unclear why an electrode constructed of three *separate* layers cannot also be construed as being [the claimed proton-electron mixed conductive material]” (italics added).

The Examiner appears to recognize that construing the claim language in light of the specification (see the italicized portion of the above quote) requires that the mixture of proton conductor materials and electron conductor materials be construed as a single material. This is the point that Applicants were making in section (a) above. The mixture of different component materials results in a single mixed material, much like flour, milk, eggs, when mixed together, become pancake batter.

The Examiner also appears to recognize that Vanderburgh discloses three *separate* layers. These separate layers are not mixed together to form a mixed material, rather, they

are layered upon each other and retain their separate material identity, much like a layer of old white paint when covered with a new layer of red paint, does not become a layer of pink paint, but retains the separate identities of the individual white and red paint layers.

Thus, Applicants maintain, as further discussed below, that Vanderborgh does not disclose the claimed electrode composition and is, thus, not relevant.

**(c) Grot discloses an electrode composition that is liquid water permeable.**

The Examiner argues in the June 14, 2010 Office Action, paragraph 60, that “Grot teaches that the binder for the electrode can contain materials such as hydrophobic polytetrafluoroethylene (*i.e.*, Teflon) and also suggests the use of surfactants ... presumably also to control the wetting ability of the electrode. Hence, [Grot’s] teachings already suggest that the hydrophobic character of the electrodes can still be controlled even though the electrodes contain Nafion, and [Grot’s] teachings suggest the use of further hydrophobic treatment.” Applicants disagree.

First, surfactants facilitate wetting or hydrophilic behavior. Additionally, Grot’s teachings as to the “use of surfactants” is for when the binders and other ingredients are being added to the suspension media of the ink (cols. 5 and 6) in order to improve the dispersibility [of these components within the ink suspension media] (col. 5, lines 65-68). Thus, contrary to the Examiner’s presumption, Grot’s teachings of the “use of surfactants” is not a teaching as to “controlling the wetting ability of the electrode” and is not a teaching “suggest[ing] the use of further hydrophobic treatment.”

Second, Grot’s teaching that other suitable binders include Teflon® or other binders (col. 5, lines 63-65) is devoid of any mention of Teflon®’s hydrophobic properties or of any mention of controlling the wetting ability of the electrode. In fact, Grot fails to link the use of Teflon® as a binder to any teaching of “controlling the hydrophobic character of the electrode.” Grot just does not teach a hydrophobic electrode.

Even further, Grot’s example electrode ink composition (col. 14, lines 15-27) includes no Teflon® (or any other binder other than Nafion®). Yet, indeed, this example electrode ink composition of Grot’s is the very disclosure relied upon by the Examiner for allegedly disclosing the claimed electrode composition. Nor is there any further discussion or suggestion in Grot, with respect to this electrode ink composition, of “controlling the

hydrophobic character of the electrode" or of "the use of further hydrophobic treatment." Rather, as discussed below, Grot explicitly states that "the membrane and electrode structure is also useful in electrolytic cells" (col. 13, lines 35-36). As electrolytic cells involve the electrolysis of aqueous solution, it is preferable that these electrodes be liquid permeable. In other words, rather than seeking to make its electrodes hydrophobic, Grot embraces the liquid permeability of its electrodes.

- (d) Surampudi evidences that persons of ordinary skill in the art would have known that the addition of Nafion® to an electrode composition would make the electrode more liquid permeable.

The Examiner argues in the June 14, 2010 Office Action, paragraphs 59 and 60, that "it is unclear how Surampudi is relevant to the present issues when Surampudi didn't disclose the use of any wetting [sic, anti-wetting?] treatments and when none of the secondary teachings [Grot, et al.] considered the switch from Teflon® to Nafion® to be detrimental to the electrode function."

First, in the context of the *individual* prior art references, there is no reason for any of the references to consider the addition of Nafion® to be detrimental. Indeed, Grot discloses that the use of Nafion® is preferred, among other reasons, because the electrode ink with Nafion® as a binder readily adheres to the membrane (see col. 4, lines 15-29). However, Grot says nothing of operating its electrode as a "gas-diffusion electrode" when the electrode is immersed in liquid water. It is under these conditions (which, indeed, are the disclosed operating conditions of the Dempsey device), that Applicants submit that the use of Nafion® as disclosed by Grot is detrimental.

Applicants rely on Surampudi as evidence that a person of ordinary skill in the art, at the time of the invention, would have recognized that Grot's use of Nafion® as the electrode binder would have produced an electrode that allows liquid to penetrate its pores, and that such a liquid permeable electrode would be flooded and rendered inoperable under the Dempsey operating conditions (i.e., operation of Grot's electrode as a "gas-diffusion electrode" when immersed in liquid water would be impossible).

Surampudi discloses that the structure and properties of an electrode for use in liquid feed type fuel cells are quite different from the structure and properties of an

electrode for use in gas/vapor feed fuel cells (col. 2, lines 34-42). This disclosure of Surampudi, at the very least, teaches that fuel cell electrodes are not willy-nilly interchangeable—always, the operating conditions must be considered when selecting a suitable electrode composition.

Surampudi discloses that an electrode having a Teflon® binder will not flood, but an electrode having a Nafion® binder will be liquid permeable. For example, Surampudi discloses that prior art electrodes formed as carbon-supported alloy powder combined with Teflon® binder yield gas-diffusion electrodes (col. 2, lines 25-27). Further, Surampudi discloses that these prior art gas-diffusion type electrodes cannot be effectively used in liquid feed type fuel cells as the electrode is not adequately wetted by the liquid fuel (col. 2, lines 34-37). Surampudi then discloses that “the electrode structures for use in a liquid feed fuel cell should be very porous and the liquid fuel solution should wet all pores” (col. 2, lines 37-39). Finally, Surampudi discloses that the addition of Nafion® to the electrode promotes wetting of the electrode pores, thereby providing an electrode structure suitable for liquid feed type fuel cells (col. 12, lines 41 – col. 14, line 13).

- (e) **None of the cited prior art references teach or suggest that “further hydrophobic treatment” would render a liquid permeable electrode impermeable when immersed in liquid water.**

The Examiner has indicated in the June 14, 2010 Office Action, paragraphs 59 and 60, that the secondary references (Grot, et al.) suggest the use of further hydrophobic treatments (*i.e.*, anti-wetting treatments). The Examiner further indicates that it is unclear how Surampudi is relevant to the present issues when Surampudi didn’t disclose the use of any wetting [*sic, anti-wetting?*] treatments. Thus, Applicants assume that the Examiner is suggesting that Grot’s liquid permeable electrode could be made non-liquid permeable (even when surrounded by liquid water as taught by Dempsey), while still maintaining its operability, by the addition of some further hydrophobic treatments.

First, as discussed above, Grot fails to disclose or suggest further hydrophobic treatments.

Second, there is no teaching or suggestion in any of the references that a liquid permeable electrode, such as taught by Grot, could be made non-liquid permeable by the

addition of some further hydrophobic treatments such that when surrounded by liquid water, as taught by Dempsey, it would still maintain its operability as a gas-diffusion electrode.

The Examiner asserts that Uchida teaches the use of a water repelling treatment. However, Applicants note that Uchida discloses the use of a water repelling treatment only in the context of gas-diffusion type electrodes that operate in a gas environment. In this context of a gas operating environment, Uchida discloses the addition of a fluoropolymer (e.g., Teflon<sup>®</sup>) to enhance the ability of gas feeding to the reaction site (col. 2, line 66 to col. 3, line 5). Uchida fails to disclose, suggest or discuss operating an electrode that is immersed in a liquid water environment. Thus, Uchida fails to disclose that its water repelling treatment would allow the electrode to operate if the electrode were to be immersed in liquid water. In other words, Uchida fails to disclose that a hydrophilic electrode, such as taught by Grot, could be sufficiently treated with hydrophobic materials such that the electrode would be capable of acting as a gas-diffusion electrode when immersed in liquid water.

Even further, as Applicants have previously presented (see below), Uchida discloses no more than 2 wt% of hydrophilic Nafion<sup>®</sup> in its inventive electrodes. Thus, importantly, Uchida also fails to disclose that its water repelling treatment would allow an electrode having the claimed amount of proton conductor (10-50 wt%) to operate as a gas-diffusion electrode if the electrode were to be immersed in liquid water. Thus, even further, there is no expectation that the "water repellent" teachings of Uchida would successfully keep Grot's hydrophilic electrode (with its greater amount of hydrophilic Nafion<sup>®</sup>) from flooding in Dempsey's liquid water environment.

The Examiner also asserts that Vanderburgh discloses hydrophobically treating the electrode to control the wetting of the electrode. In fact, Vanderburgh discloses that certain layers can be treated with hydrophobic materials, such as elemental fluorine, to decrease the wetting tendencies thereof. (See col. 9, lines 7-9 and col. 10, line 66 – col. 11, line 1.) "Decreasing the wetting tendencies" is not a disclosure that the treated electrode is now hydrophobic. Thus, this is not a disclosure that a hydrophilic electrode, such as taught

by Grot, could be sufficiently treated with hydrophobic materials such that the electrode would be capable of acting as a gas-diffusion electrode when immersed in liquid water.

Finally, Applicants note that the Examiner has not actually formally presented the combination of references and the rationale that are being relied upon for the presumed obviousness rejection.

- (f) **It is appropriate for Applicants to discuss Nafion® with respect to the rejection of Dempsey in view of Grot because Grot discloses that the example inventive electrode ink composition includes Nafion®.**

The Examiner argues in the June 14, 2010 Office Action, paragraph 61, that the claims are not drawn to Nafion® specifically, and thus, a less hydrophilic form of a proton-electron mixed conductive material could be used.

Applicants are arguing against the combination of references cited by the Examiner—in this case the combination of Dempsey in view of Grot. Grot discloses Nafion®. Applicants need only show that it is improper to combine Grot with Dempsey. Thus, Applicants need only show, for example, that an electrode formed from Grot's disclosed electrode ink composition would render Dempsey inoperable. Applicants are not required to include arguments directed to other hypothetical ink compositions.

The Examiner has not yet presented a *prima facie* case that Applicants' claims are rendered unpatentable in view of any reference disclosing a different proton conducting material. Should the Examiner present such a *prima facie* case, Applicants will address that rejection.

- (g) **Cisar (US 5,635,039) fails to disclose, or in any way suggest, that Nafion® has hydrophobic characteristics.**

The Examiner argues in the June 14, 2010 Office Action, paragraph 60, that Cisar evidences that Nafion® containing electrodes are not inherently plagued by flooding, because the hydrophobic or hydrophilic character of the Nafion® is a function of the ratio of the hydrophobic backbone to the hydrophilic sulfonic group concentration. Applicants disagree.

First, Cisar compares Nafion® to an experimental Dow product (not Nafion® to Nafion®) and concludes that a membrane formed of the Dow product gives rise to

increased water retention in the membrane which brings about flooding in an electrode impregnated with the Dow product, but not apparently in an electrode impregnated with Nafion® (col. 8, line 44 – col. 9, line 3). However, these electrodes are not surrounded by water—rather they are the cathodic electrodes which are surrounded by the reactant gases. Thus, importantly, Cisar never evidences that Nafion® containing electrodes are not inherently plagued by flooding when surrounded by water (as disclosed by Dempsey). Even further, Cisar never evidences that Grot's Nafion® containing electrodes will not flood when surrounded by water.

Second, Applicants strenuously disagree with the Examiner's assertion that "some Nafion® [has] a high degree of hydrophobic character." The Examiner has presented no evidence in support of this assertion. Cisar never evidences nor suggests in any way that Nafion®, itself, has a hydrophobic character. Nor does Cisar ever evidence that the "hydrophobic or hydrophilic character" of Nafion® is a function of the ratio of the hydrophobic backbone to the hydrophilic sulfonic group concentration. Further, Vanderborgh's disclosure cited by the Examiner, that different ion exchange polymers have different wetting properties, is not a disclosure that any of the ion exchange polymers have hydrophobic characteristics.

Should the Examiner maintain his assertion that Nafion® may be hydrophobic or that Nafion® may have a high degree of hydrophobic character, Applicants respectfully request supporting documentation.

**(h) Dempsey discloses flooding one side of the solid polymer electrolyte membrane with water.**

The Examiner argues in the June 14, 2010 Office Action, paragraph 62, that "although applicant discusses Dempsey's use of flooding in great detail, one possessing ordinary skill in the art would have recognized that there are other means for self-humidifying a polymer electrolyte that don't involve the use of flooding." The Examiner then refers to LaConti for its teaching that self-humidifying can be accomplished by water vapor.

Applicants have argued, as presented in more detail below, that there is a significant difference between humidifying a solid polymer electrolyte membrane with

liquid water as opposed to water vapor. Dempsey goes to great lengths to form and maintain a hydrated solid polymer electrolyte bridge, via flooding with liquid water. Applicants have presented evidence that exposing a solid polymer electrolyte membrane to water vapor is not equivalent to exposing it to liquid water (see discussion of Onishi, below, and “Schroeder’s paradox”). In short, Onishi teaches that the water uptake of a Nafion® membrane exposed only to water vapor could be half that of the water uptake of the membrane exposed to liquid water. In other words, humidifying with water vapor is not equivalent to humidifying with liquid water.

Dempsey also discloses that its hydrated solid polymer electrolyte bridge is critical to Dempsey’s operation. Thus, Dempsey teaches away from reducing the functionality of this hydrated solid polymer electrolyte bridge.

**(i) Combining Nagata with Dempsey changes Dempsey’s principle of operation and renders Dempsey unsatisfactory for its intended purpose.**

The Examiner argues in the June 14, 2010 Office Action, paragraphs 66 and 69, that Nagata shows that “sensors can be construct[ed] both with and without reference electrodes” and “that one possessing ordinary skill in the art would have recognized that a reference electrode is not necessary for successful gas sensing.” The Examiner also asserts that Applicants’ argument—that “if Dempsey didn’t utilize a reference electrode, then [Dempsey’s] sensor wouldn’t be a potentiostated sensor anymore”—is irrelevant. Applicants disagree.

If one were to eliminate the reference electrode from Dempsey, as the Examiner urges, (1) Dempsey’s principle of operation would be changed and (2) Dempsey’s gas sensor would be rendered unsatisfactory for its intended purpose. Both of these are impermissible.

As to the first point, it is improper to propose to modify the prior art reference such that the principle of operation of the prior art reference would be changed (MPEP 2143.01(VI)). In this instance, combining Dempsey with Nagata would require a substantial reconstruction and redesign of the elements shown in Dempsey, as well as a change in the basic principle under which Dempsey was designed to operate. As disclosed in more detail below, Dempsey’s basic principle of operation is based on the sensor being

a potentiostated sensor such that the sensor's output current may be temperature compensated. Under this principle of operation, the sensing electrode, among other things, is biased to maintain its potential at or above the rest potential of the reference electrode by a fixed amount (col. 2, lines 36-51). The elimination of the reference electrode, as urged by the Examiner in view of Nagata, would completely gut Dempsey's principle of operation.

As to the second point, the proposed elimination of the reference electrode would improperly render Dempsey unsatisfactory for its intended purpose (MPEP 2143.01(V)). Dempsey's gas sensor is intended to be very stable with temperature at zero-air operation (see Title and col. 1, lines 9-12). As discussed in more detail below, if Dempsey was converted from a three-electrode sensor to a two-electrode sensor it would, it would no longer have the means to account for temperature variations during zero-air operations.

The Examiner has failed to provide any reasoned analysis that would support his assertions that it would be obvious to eliminate Dempsey's reference electrode, yet still maintain Dempsey's principle of operation and/or not render Dempsey unsatisfactory for its intended purpose. Should the Examiner maintain these rejections, Applicants respectfully request that the Examiner provided the missing reasoned explanations.

**(j) Combining Tomantschger '166 with Grot renders Tomantschger unsatisfactory for its intended purpose.**

The Examiner recognizes in the June 14, 2010 Office Action, paragraph 68, that Tomantschger '166 "appears to be primarily interested in the use of hydrophobic binders [in the electrodes] as a means to prevent liquid electrolyte loss," but argues that because "Tomantschger also discloses that the electrolyte can be a solid polymer like Nafion ... the alleged criticality the that electrode of Tomantschger be hydrophobic is moot." Applicants disagree.

Although Tomantschger '166 discloses that the electrolyte may be a solid polymer electrolyte, Tomantschger '166 fails to disclose that using such a solid polymer electrolyte eliminates a leakage concern. First, there is no express or implicit disclosure in Tomantschger '166 that use of a solid polymer electrolyte means that there is no liquid (such as water) associated with the polymer electrolyte. And, in fact, Tomantschger '274

(a continuation-in-part of Tomantschger '166) discloses that "when a substantial portion of the third frame contains a solid electrolyte," "a liquid reservoir such as water, in the case of a NAFION solid polymer electrolyte, can be incorporated into the first and second frame member." (See Tomantschger '274, Fig. 5 and col. 10, lines 32-40.) Thus, even if Tomantschger '166 discloses the possible use of a solid polymer electrolyte such as Nafion®, the reservoir liquid such as water must still be prevented from leaking. In other words, Tomantschger '166 still requires hydrophobic electrodes, even if a solid polymer electrolyte is used.

Thus, replacing the hydrophobic electrodes of Tomantschger '166 with Grot's hydrophilic electrodes with render Tomantschger inoperative and unsatisfactory for its intended purpose.

#### V. Discussion of Certain Key Issues Previously Raised by the Examiner

##### a. Nafion®

Applicants have previously asserted that Surampudi (US 5,599,638) teaches that Nafion® is a "non-hydrophobic binder"—a binder that when added to hydrophobic electrodes, i.e., electrodes having poor wetting properties, converts the electrodes to non-hydrophobic electrodes, i.e., electrodes having good wetting properties. In the past, relying at least in part on the disclosure of Razaq (US 5,322,602), the Examiner has indicated that Nafion® is "a well-known hydrophobic polymer." Applicants disagree.

Nafion® is a co-polymer of tetrafluoroethylene and perfluorovinylether sulfonic acid (see, e.g., Surampudi, col. 3, lines 60-64). Nafion® has a hydrophobic backbone (Teflon) with sulfonic acid ( $\text{SO}_3\text{H}$ ) side groups. The sulfonic acid side groups are hydrophilic (see Onishi L. et al., "Water-Nafion Equilibria. Absence of Schroeder's Paradox," (2007) The J. of Phys. Chemistry, B 2007;111(34):10166-73 (Abstract previously supplied) [<http://www.electrochem.org/meetings/scheduler/abstracts/212/0190.pdf>]). Surampudi refers to Nafion® as a "hydrophilic proton-conducting polymer (see col. 12, lines 60-63). Applicants further previously provided a copy of a "Material Safety Data Sheet for Nafion® 117" supplied by Sigma-Aldrich. At page 3, this data sheet discloses that Nafion® is hygroscopic, i.e. capable of easily absorbing moisture. Thus, it is clear that the hydrophilic nature of Nafion's sulfonic acid side groups impart hydrophilic or

hygroscopic properties to Nafion® as a whole. And, in fact, Razaq (cited by the Examiner) discloses that it is well known that Nafion is hydrophilic (see col. 7, lines 54-59).

Importantly however, Surampudi goes beyond merely teaching that Nafion® has hydrophilic side groups and hydrophilic properties. Surampudi teaches that gas-diffusion type electrodes, which have poor fuel wetting properties, can be modified for use in liquid feed cells by including substances that improve their wetting properties, *e.g.*, Nafion® (col. 4, lines 10-21). Surampudi discloses that the addition of Nafion® to an electrode allows the liquid surrounding the electrode to flow into or wet the pores, thus creating a liquid-feed type electrode. In other words, Surampudi teaches that electrodes having poor wetting properties (*i.e.*, hydrophobic electrodes) can be converted to electrodes having good wetting properties (*i.e.*, non-hydrophobic electrodes) by the addition of Nafion®. It is in this context that Applicants referred to Nafion® as a “non-hydrophobic binder,” *i.e.*, when added to an electrode in sufficient quantity Nafion® allows water to flow into and flood the pores of the electrode. A flooded electrode cannot operate as a gas-diffusion type electrode—in other words, a flooded electrode cannot be used to react with (or sense) gases.

b. Certain Cited Prior Art

Dempsey

Dempsey discloses flooding one side of a solid polymer electrolyte membrane with distilled water. Specifically, a water channel 7, connected to reservoir 1 via hydrated ports 5 and 6, is positioned over an ionically conductive, hydrated SPE bridge 8 formed on the upper surface of membrane 9. (See Fig. 1; col. 4, lines 30-46.) Further, Dempsey expressly discloses that “the surface of the counter electrode and the membrane area around the electrode is flooded.” (Col. 4, lines 46-49.)

Dempsey’s principle of operation relies on flooding one side of the membrane with distilled liquid water. Dempsey discloses that this flooding of the membrane with distilled water provides “self-humidification,” *i.e.*, transport of water in the vapor phase across the membrane. (Col. 7, lines 50-54, referring to Nolan et al. (US 4,171,253) which discloses, at col. 3, lines 22-26, that “this self-humidifying arrangement is possible in SPE-type gas sensor by maintaining the side of the SPE membrane away from the gas side, *i.e.*, away

from the side containing the sensing electrode flooded with distilled water.") Dempsey further discloses that by eliminating the possibility that the membrane will dry out and by providing an ionically conductive, hydrated SPE bridge, the output current from the device is improved. (Col. 3, line 64 to col. 4, line 10.) Thus, Dempsey teaches that flooding one side of the membrane with distilled liquid water is important for its principle of operation.

With respect to the electrodes, Dempsey discloses that the electrodes are each "a bonded mass of particles of a platinum-5% iridium alloy and *hydrophobic* particles such as polytetrafluoroethylene." (Col. 5, lines 29-33; see also, col. 7, lines 25-31; col. 7, line 65 to col. 8, line 4; col. 8, lines 27-29. Emphasis added.) Dempsey further discloses that "the nature and characteristics of an electrode, comprising a mixture of particles of a gas absorbing noble metal bonded with particles of *hydrophobic* material as well as the process for doing so, are described in detail in U.S. Pat. No. 3,432,355 ["Niedrach"] ...." (Col. 8, lines 31-44. Emphasis added.) Niedrach, in turn, discloses that the electrodes are purposely made *hydrophobic* to prevent flooding/drowning<sup>1</sup> of the electrode when in contact with water:

The electrodes comprise gas absorbing metal particles bonded together into a cohesive mass with polytetrafluoroethylene and having a coating of polytetrafluoroethylene bonded to the electrode surface in contact with the gas phase. These novel electrode structures, when used in combination with the aqueous electrolyte ... do not require special fabrication or additional precautions to prevent the electrolyte from flooding the surface of the

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<sup>1</sup> "Flooding" refers to the penetration of electrolyte into hydrophobic regions of the catalyst layer which should contain only gas. This misplaced liquid hinders and may totally obstruct the supply of reactant gas to local regions of the catalyst. As a result there is an increase in electrode polarization as the non-flooded regions of the electrode are forced to carry more current. The process is self-propagating and will eventually lead to cell failure. In fuel cells having an acid electrolyte the flooding phenomenon is most prevalent at the cathode *i.e.*, at the water-producing electrode. (See WO/1993/003505) High Current Acid Fuel Cell Electrodes.)

See also, EP0046086: "Early in the development of electrodes for fuel cells it was realised that porous, hydrophobic electrodes were desirable especially for use as a hydrogen anode in order to achieve proper control of electrode wetting and to prevent flooding thereof by the electrolyte so that both the reaction gases and the electrolyte had satisfactory access to the electro-catalyst in the electrode."

electrode in contact with the gas phase, and thereby "drowning" the electrode which would deleteriously affect the performance of the fuel cell reaction." (Col. 1, lines 19-30.)

Thus, Dempsey discloses (via its citation to Niedrach and its repeated express disclosure that the electrode binder is hydrophobic) that its electrodes are impervious to the water such that flooding/drowning of the electrode does not occur.

In sum, Dempsey teaches that the counter electrode must be surrounded with distilled liquid water in order to keep the membrane and the ionically-conducting bridge on the membrane, hydrated. Dempsey further teaches the necessity that the electrode be hydrophobic so that drowning of the electrode in the aqueous environment does not occur.<sup>2</sup>

Uchida, Grot and Vanderborgh

The Examiner has cited to Uchida, Grot and Vanderborgh because each of these references teach, in the context of fuel cells and/or electrolytic cells, the addition of Nafion® to an electrode composition.

However, a person of ordinary skill in the art at the time of the invention would have known that the addition of Nafion® to an electrode composition in sufficient quantity would make the electrode non-hydrophobic. For example, US 5,599,638 to Surampudi et al. (filed October 12, 1993, and thus indicative of the knowledge of a person of ordinary skill in the art at the time of the invention) discloses that two major categories of electrodes exist: gas-diffusion type electrodes and liquid-feed type electrodes (col. 2, lines 35-48). Surampudi discloses that electrodes formed of carbon-supported alloy [catalyst] powder and a Teflon® binder yield a gas diffusion electrode (col. 2, lines 25-27). According to Surampudi, gas-diffusion type electrodes, which have poor fuel wetting properties, can be modified for use in liquid feed cells by including substances that improve their wetting properties, e.g., Nafion® (col. 4, lines 10-21). Surampudi discloses that the addition of Nafion® to an electrode allows the liquid surrounding the electrode to flow into or wet the pores, thus creating a liquid-feed type electrode. *In other words, Surampudi teaches that*

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<sup>2</sup> Further, with respect to the Examiner's assertion that Dempsey recognizes that electrodes set forth in the fuel cell prior art would find utility in the sensor of Dempsey (citing to col. 8, lines 30-63, as justification for citing to Uchida, Vanderborgh or Grot), Applicants submit that this recognition by Dempsey of fuel cell prior art electrodes is limited to **hydrophobic** electrodes, such as those taught by Niedrach.

*electrodes having poor wetting properties (i.e., hydrophobic electrodes) can be converted to electrodes having good wetting properties (i.e., non-hydrophobic electrodes) by the addition of Nafion®.*

Even further, as would be expected, Surampudi discloses that the amount of Nafion® affects the properties of the electrodes. “Electrode compositions with additive in excess of 10% [of the weight of the electrocatalyst] may result in an increased internal resistance of the fuel cell and poor bonding with the solid polymer electrolyte membrane. Compositions with less than 2% of the additive do not typically result in improved electrode performance.” In fact, Surampudi teaches that the desired amount of additive is in the range of 2-10% of the weight of the electrocatalyst.

Surampudi teaches that Uchida, Grot and Vanderborgh, by disclosing the addition of Nafion® to the electrode compositions, all disclose liquid-fuel type electrodes of varying degrees, i.e., electrodes that will allow water to penetrate their pores.<sup>3</sup>

Uchida is Not Relevant

Uchida fails to disclose electrodes having the claimed composition, i.e., a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material.

Example 1 of Uchida discloses that 1g of Nafion® polymer was added to 60g of n-butyl acetate to form a colloidal dispersion. Then 50g of Pt-C (having 10-25% platinum catalyst) were added to this colloidal dispersion. The resulting paste was coated on carbon paper. Thus, the disclosed electrode of example 1 has 2.0 wt% proton conductor material (1g Nafion® / (1g Nafion® + 50g Pt-C)) and 98 wt% electrical conductor material (50g Pt-C / (1g Nafion® + 50g Pt-C)).

Examples 2-6 maintain the same solids ratios, merely swapping out the organic solvents.

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<sup>3</sup> A liquid-fuel type electrode can be used in a non-liquid environment and operated as a gas-diffusion electrode. However, if a liquid-fuel type electrode is used in a liquid environment, it cannot then operate as a gas-diffusion electrode, as its pores will be flooded.

Example 7 adds an additional 25g of carbon powder (having 25-70 wt% PTFE) to the colloidal dispersion. Thus, the disclosed electrode of example 7 has 1.3 wt% proton conductor material (1g Nafion® / (1g Nafion® + 50g Pt-C + 25g C/PTFE)) and 75.7 wt% to 90.4 wt% electrical conductor material ((50g Pt-C + 30% to 75% of (25g C/PTFE)) / (1g Nafion® + 50g Pt-C + 25g C/PTFE)).

Thus, while the claims require 10-50 wt % of a proton conductor material, none of the inventive examples of Uchida have a wt % of Nafion® that exceeds 2.0 wt %.

Uchida's comparative example is disclosed at col. 7, line 54 to col. 8, line 7. Uchida's comparative example does not explicitly disclose the amounts of the Pt-C component (10-25 wt% platinum) or of the C/PTFE component (25-70 wt% PTFE). Uchida discloses that the Pt-C and the C/PTFE are sprinkled on carbon paper and hot pressed to form an electrode. This hot pressed Pt-C with C/PTFE layer does not include a proton conductor material.

At the top of col. 8, in a new paragraph, Uchida discloses that a *coat* of Nafion® is applied to the previously hot-pressed catalyst layer of the electrode. In other words, in the comparative example, Uchida discloses that the Nafion® coat is a separate layer formed on the electrode after the electrode has been hot pressed. This separate Nafion® layer does not include any electrical conductor material.

Thus, with respect to the comparative example, Uchida fails to disclose any material having a proton-electron mixed conductive material. Rather, Uchida discloses two material layers: the hot pressed Pt-C with C/PTFE layer (and with no proton conductor material) and the Nafion® layer (with no electrical conductor material). These two distinct layers do not form a single proton-electron mixed conductive material as required by the claims of the instant application.

And, in fact, this is exactly the point of Uchida's comparative example—to compare the separate Nafion® and carbon layers of the comparative example to Uchida's inventive examples, which have a low level of Nafion® mixed in with the electrical conductor material. Given this, it is irrelevant what weight percent this separate Nafion® proton conductive layer has relative to the Pt-C with C/PTFE electron conductive layer.

Thus, neither Uchida's inventive examples (Examples 1-7) nor Uchida's comparative example disclose a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material.

Vanderborgh is Not Relevant

Vanderborgh fails to disclose electrodes having the claimed composition, *i.e.*, an electrical conducting material that is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material.

Vanderborgh discloses that an object of the invention is to provide a composite electrode which is constructed to have increasing electronic conductivity from the catalyst loading zone to a current collector on one face of the electrode, and to have increasing protonic conductivity from the zone of the catalyst loading to the face of the electrode which engages the ion exchange membrane. (Col. 3, lines 37-44).

Vanderborgh accomplishes this by providing an electrode comprised of three zones or layers. Referring to FIG. 2, Vanderborgh discloses that the composite electrode is formed of three separate layers (22, 24 and 26) thermally bonded to each other (col. 8, lines 13-15; col. 8, lines 59-62). Each layer comprises a mixture of carbon black, platinum, PTFE and a suitable ionic conducting material (col. 8, lines 16-20).

Table I discloses the compositional parameters for each layer. Layer 22 has a proton conducting material weight percent of 4.3% (.021/.491) and an electrical conducting material weight percent of 82.3% (.304/.491). Layer 24 has a proton conducting material weight percent of 4.4% (.119/2.718) and an electrical conducting material weight percent of 91.2% (2.48/2.718). Layer 26 has a proton conducting material weight percent of 74% (.422/.570) and an electrical conducting material weight percent of 12.1% (.069/.570). None of these layers has 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material, as required by the claims.

Further, as discussed above, it would be improper to consider the entire composite electrode of Vanderborgh as a single electrical conducting material, *i.e.*, to consider the three separate layers 22, 24, 26 to be a single material. Each separate layer of the electrode is a distinct material—bonding the layers together does not form a new “material.”

Grot Discloses Liquid Permeable Electrodes

In the example referred to by the Examiner, Grot discloses using a non-hydrophobic binder (Nafion®) for its fuel cell electrode (col. 14, lines 15-27). In addition to the teachings of Surampudi, discussed above, (*i.e.*, that the addition of Nafion® to an electrode composition creates a non-hydrophobic, liquid-fuel type electrode), Grot expressly discloses that the electrode is a “*gas-liquid* permeable porous electrode.” (Col. 1, lines 31-32; emphasis added.) Thus, Grot explicitly discloses that its electrode is a liquid-fuel type electrode, *i.e.*, an electrode that is specifically designed to allow the penetration of the liquid into the pores of the electrode.

Grot further explicitly discloses that its membrane and electrode structure is useful in electrolytic cells where, for example, the anode electrolyzes an aqueous solution. Thus, again Grot discloses that the electrode is a liquid-fuel type electrode (col. 13, lines 35-50).

c. The Proposed Combination of References Changes Dempsey's Principle of Operation and, in fact, Renders Dempsey Unsatisfactory for its Intended Purpose

The Examiner has indicated that it would have been obvious to utilize the teachings of Uchida, Grot and/or Vanderborgh for the sensor of Dempsey. Applicants disagree.

As an initial matter, as discussed above, Uchida and Vanderborgh do not disclose the claimed electrode composition.

If one were to replace the hydrophobic electrodes, as repeatedly and expressly taught by Dempsey, with non-hydrophobic electrodes as disclosed by Grot, Dempsey's principle of operation would be changed. In fact, Dempsey would be rendered inoperable or, at the very least, unsatisfactory for its intended purpose due to flooding of the electrodes of Grot.

Dempsey teaches a gas sensor that uses a gas permeable (*i.e.*, a gas-diffusion type) electrode. However, Dempsey also teaches surrounding the area of the counter electrode with distilled liquid water. Dempsey then further explicitly and repeatedly teaches using a hydrophobic binder for the electrodes. (Col. 8, lines 34-44.) Specifically, Niedrach (cited by Dempsey to disclose the electrodes used in the gas sensor of Dempsey and the process of making these electrodes) explicitly teaches using hydrophobic electrodes so that the electrodes will not “drown” in an aqueous environment (Niedrach, col. 1, lines 19-30). In essence, Dempsey teaches away from using a non-hydrophobic binder for the electrodes.

Grot discloses including a non-hydrophobic binder (Nafion®) in its fuel cell electrodes.

Surampudi teaches that the inclusion of Nafion® in the electrode composition converts a gas-diffusion type electrode into a liquid-fuel type electrode, *i.e.*, a non-wetting electrode is converted into a wetting-type electrode.

A person of ordinary skill the art would realize that replacing Dempsey's gas-diffusion type, hydrophobic electrodes with liquid-fuel type electrodes as taught by Grot would result in the electrodes being flooded/drowned with Dempsey's distilled water, such that the gas to be reacted would be unable to reach the reaction sites within the electrodes. (See discussion of Surampudi, above.) Simply put, the electrodes would be flooded and Dempsey's gas sensor would be unable to sense or react to the gas. Thus, contrary to the Examiner's assertion, as the combination renders Dempsey's sensor inoperable, one of ordinary skill in the art would have reason to NOT replace the hydrophobic electrodes of Dempsey with the non-hydrophobic electrodes of Grot.

## V. Res Judicata

### a. Claims 95 and 96

The Examiner has specifically rejected reissue claims 95 and 96 on the grounds of *res judicata*, because the rejections of the similar reexamination claims 79 and 80 were affirmed by the Board of Appeals in a Decision of May 23, 2007 in Reexamination 90/006,208. However, the Examiner has also noted that reissue claims 95 and 96 are not identical to the reexamination claims 79 and 80 that were presented in Reexamination 90/006,208. In particular, reissue claim 95 includes the recitations of original claims 1, 8 and 14, and this combination of recitations was not, in and of itself, before the Board of Appeals in Reexamination 90/006,208. Reissue claim 96, which depends from claim 95, thus includes the recitations of original claims 1, 8, 14 and reexamination claim 80, and this combination of recitations was also not, in and of itself, before the Board of Appeals in Reexamination 90/006,208. Further, with respect to reissue claims 95 and 96, Applicants present new evidence (see *e.g.*, at least, Surampudi et al.) than that which was before the Board in the earlier decision. This alone renders the doctrine of *res judicata* inapplicable

and mandates that the Examiner substantively examine these claims. In short, the current prosecution of reissue claims 95 and 96 presents amended claims and a new record, and these differences in the claims and this new record prohibits the application of *res judicata*.

b. *Res Judicata, Generally*

In the Patent Office, the doctrine of *res judicata* is to be invoked rarely and only when the same claims (or patentably indistinguishable claims) and the same evidence (regarding the patentability or the unpatentability of the claims) is applied to these claims in the same manner as was previously presented to the Board. In this instance, the evidence and at least some of the claims are not the same as was previously presented to the Board.

The Examiner is required to substantively examine the claims and grant patents that comply with the patent statute. This is so, whether or not the application has previously been considered by the Board. The Board has stated, "the policy and purpose of the patent laws preclude the applicability of any doctrine akin to the judicially-developed doctrine of "res judicata" to bar the granting of patents on inventions that comply with the statute," (*Ex parte Conte*, BPAI No. 2000-2033, decided September 2001, citing to *In re Craig*, 411 F.2d 1333, 56 C.C.P.A. 1438 (1969)). The courts have stated, "*res judicata* does not have its usual impact when considering ex parte patent appeals; the public interest in granting valid patents outweighs the public interest underlying collateral estoppel and *res judicata*, particularly where the issue presented is not substantially identical to that previously decided." (*In re Oelrich*, 666 F.2d 578 (Fed. Cir. 1981), fn 2 (citing to *In re Russell*, 58 CCPA 1081, 1083, 439 F.2d 1228, 1230, 169 USPQ 426, 428 (1971); *In re Craig*, 56 CCPA 1438, 1441-42, 411 F.2d 1333, 1335-36, 162 USPQ 157, 159 (1969).) In other words, if the claims being prosecuted comply with the patent statute, they should be granted.

Additionally, *res judicata* does not automatically apply just because there is an earlier decision by the Board of Appeals. In fact, the MPEP recognizes that the invocation of *res judicata* by the Patent Office has been materially restricted by the courts. (MPEP 706.03(w).) Referring to *In re Craig*, 162 USPQ 157 (CCPA 1969), cited in MPEP 706.03(w), the Court found that the Board of Appeals had improperly sustained the

rejection of the claims under the doctrine of *res judicata* (based on an earlier Board decision for the parent application), even though the Board found the claims to be otherwise patentable. The Court reversed the Board's holding, stating that "claims should not be refused merely because on a previous occasion [i.e., the earlier Board decision] the same or similar claims have been refused on grounds no longer deemed to be valid." *Craig* at 159. In other words, the doctrine of *res judicata* is not binding on the Patent Office.

The *Craig* Court explained that the doctrine of *res judicata*, in the context of patent prosecution, must be balanced against the mandate of the Patent Office to grant patents to inventions that are patentable under the substantive provisions of the patent statute:

"While *res judicata* has its proper place in the law as a reflection of a policy invoked to settle disputes and put an end to litigation, the prosecution of patent applications is not exactly either a dispute or litigation in the usual sense of these terms. There are additional public policy considerations which have a bearing here, namely, furtherance of the policy inherent in the patent laws to grant patents when the Patent Office finds that *patentable* inventions have been disclosed and properly claimed so that such inventions are made public through the grant. The granting of such patents is also in the public interest .... Society stands to lose ... when a patent is refused on an invention which is patentable under the statute." *Craig* at 159.

Further, in *In re Kaghan*, 156 USPQ 130 (CCPA 1967), the Court found that the Patent Office was actually estopped from rejecting claims solely on the theory of *res judicata*. "A holding of *res judicata* without reliance on any other ground of rejection is not an examination on the merits of the application and so may not be used [following an adverse Board of Appeals decision]." *In re Craig* at 160, citing to *In re Kaghan*. This express admonition is in keeping with the guidance in MPEP 706.03(w), that "when making a rejection on *res judicata*, action should ordinarily be made also on the basis of prior art, especially in continuing applications." In other words, the MPEP directs the Examiner to determine whether the claims are substantively patentable, and if patentable, allowance of those claims should not be refused merely because on a previous occasion the same or similar claims were refused on grounds no longer deemed to be valid.

Even further, application of the doctrine of *res judicata* is especially improper, as in this instance, where a new record (*i.e.*, new or amended claims and/or new evidence) is

before the Patent Office. First, in this reissue application, Applicants present claims (claims 79-94 and 97-113) that were not before the Board in the reexamination appeal. With respect to these claims, Applicants submit that the bare invocation of *res judicata* as sufficient rationale for combining Dempsey with Uchida, Vanderborgh or Grot is improper. Second, Applicants have presented new evidence (*i.e.*, see below, at least Surampudi, Onishi, and the Sigma-Aldrich Material Safety Data Sheet for Nafion 117, if not also, Nolan and Neidrach, etc.) in support of the patentability of the claims. Third, the Examiner has even presented new evidence and/or cited new combinations of references in the rejections of the claims (at least, Cisar (US 5,635,039), Nagata (US 4,913,792) and Tomantschger (US 5,173,166) to support his assertions of unpatentability. Thus, as the record now before the Patent Office is not the same record that was before the Board when it issued its earlier decision, the doctrine of *res judicata* does not apply.

The predecessor court to the Federal Circuit has held that claims should be examined when a new record (either amended claims and/or new evidence) present a new issue from that previously addressed. *See MPEP 706.03(w); In re Herr*, 377 F.2d 610, 153 USPQ 548 (CCPA 1967) (claims should have been examined even though claims were identical with claims previously held unpatentable on appeal in the parent application; new evidence submitted); and *In re Russell*, 439 F.2d 1228, 169 USPQ 426 (CCPA 1971) (claims should have been examined even though claims were similar to claims as previously appealed; new Rule 132 affidavits submitted). More recently, in *Ex Parte Gharib* (BPAI No. 2007-0113, October 2007), the Board held that the submission of new evidence, *i.e.*, evidence that was not before the panel in reaching their earlier decision, and the difference in the scope of the claims, presented the Board with a different record than in the earlier appeal. According to the Board, this new record required it to consider and weigh anew the totality of the evidence – the doctrine of *res judicata* did not apply. In *Gharib*, the “new evidence” was an article that predated the filing of the original application. In other words, the “new evidence” was evidence that was newly presented in the prosecution—it was not evidence that was unavailable at the time of the earlier decision.

In another fairly recent decision, *Ex Parte Rexnord Industries, LLC* (BPAI No. 2007-3920, decided September 2007), the Board held that it was improper for an examiner to invoke *res judicata* without careful consideration of the basis for his reliance on the doctrine of *res judicata*:

“Preclusions, including *res judicata*, are powerful and necessary procedural tools, but they are not magic bullets. Proving a preclusion generally requires careful construction of a supporting case. The present appeal illustrates some of the many ways in which a “*res judicata*” theory can go awry.<sup>8</sup> Since the *res judicata* theory has not been adequately developed in the record before us, we do not give it any weight.”

Footnote 8 of the *Rexnord* Board’s decision states, “There is an implication of serious prosecution misconduct in the *res judicata* argument....” Although the link is not explicit, Applicants believe that the Board’s footnote 8 was referring to this statement found in the *Rexnord* Appellant’s Reply Brief, dated January 30, 2007, p. 4:

“Prior to the Examiner’s Answer, the Appellant’s arguments traversing this rejection were ignored on the basis of *res judicata*. As discussed below, the Examiner continues to erroneously rely on *res judicata* as support for the double patenting rejection and dismiss Appellant’s reasoned analysis supporting allowance of claim 3.”

In other words, an examiner cannot summarily and conclusorily invoke *res judicata* to thereby refuse to consider Applicants’ substantive analyses as to the patentability of the claims.

Applicants respectfully submit that the new record in the present application presents a new issue that entitles Applicants to the substantive examination of the claims.

Applicants previously supplied courtesy copies of *In re Craig*, *Ex Parte Gharib*, *Ex Parte Rexnord*, and the Reply Brief of *Ex Parte Rexnord*.

## **VI. Response to Rejections in the Office Action dated June 14, 2010**

### *i. Claims 79, 81, 86, 88 and 97*

Claims 79, 81, 86, 88 and 97 stand rejected over Dempsey et al. (US 4,277,984) in view of Nagata et al. (US 4,913,792) and any of Vanderborgh et al. (US 4,804,592), Uchida et al. (US 5,474,857) and/or Grot et al. (US 5,330,860). Applicants traverse these rejections as follows.

As an initial matter, as discussed above, Dempsey teaches away from using an electrode as taught by Grot (and Uchida and Vanderborgh are not relevant). Further, there is no reasonable expectation of success for the combination of Grot with Dempsey. And, in fact, Applicants have shown above that combining Grot with Dempsey would render Dempsey inoperable. Nagata fails to cure these deficiencies.

Nagata discloses three -electrode gas sensors. Nagata further discloses that for certain configurations of three-electrode sensors, operating under certain conditions and accompanied by specific modifications to the electrodes, the reference electrode of a three-electrode sensor can be eliminated. The Examiner relies upon the disclosure of Nagata to assert that gas sensors in general may be readily transferable between a three-electrode gas sensor and a two-electrode gas sensor (OA, p. 6). Applicants disagree and submit that the Examiner is improperly applying the teachings of Nagata to Dempsey.

First, Dempsey's principle of operation would be completely changed should it be converted from a three-electrode sensor to a two-electrode sensor, *i.e.*, should its third electrode (the reference electrode) be eliminated. The entire focus of Dempsey's disclosure is the interaction of the reference electrode with the sensing electrode such that Dempsey's potentiostated, three-electrode sensor will have highly invariant background current characteristics with temperature during zero-air operation (see Title). Without a reference electrode, Dempsey would no longer be a potentiostated sensor. The Examiner recognizes this and indicates that obviating the need for a potentiostated sensor simplifies the circuitry and is therefore an advantage. While this may or may not be true (note that the contemporaneously filed application, S/N 773,136 to LaConti (sic, Nolan) referred to in Dempsey indicated that the potentiostated, three-electrode sensor solved certain problems associated with non-potentiostated, two-electrode sensors), the point is that *Dempsey's entire principle of operation is based on the sensor being a potentiostated sensor having a reference electrode*. For example, Dempsey teaches that, although the cell output current may be temperature compensated to cancel errors due to changes in temperature (see Fig. 3 and col. 9, lines 37-62), Dempsey's use of the reference electrode eliminated the need for temperature compensation under "zero-air" conditions. This use of the reference electrode is a key feature of Dempsey's principle of operation. As another example, should

Dempsey no longer have a reference electrode, it would no longer have a use for a swollen, hydrated, ionically conductive bridge between the sensing and reference electrode. Yet, this bridge is a key feature of Dempsey's principle of operation. In short, to even consider Dempsey without a reference electrode is meaningless, as the reference electrode is central to Dempsey's structure and operation.

Further, the three-electrode sensor of Dempsey differs significantly from the three-electrode sensor of Nagata, and thus, one would not consider applying the teachings of Nagata's three-electrode sensor to the three-electrode sensor of Dempsey. Even further, because of the significant differences between the three-electrode sensors of Dempsey and the three-electrode sensors of Nagata, Nagata's teaching that two-electrode sensors may be utilized in place of three-electrode sensors is not applicable to the sensors of Dempsey. Some of the significant differences between the three-electrode sensor of Dempsey and the three-electrode sensor Nagata include:

- Dempsey's sensing electrode is maintained at a fixed potential above the reference electrode to produce rapid oxidation of the gaseous constituent to be detected and above the rest potential of the electrode in the uncontaminated atmosphere (col. 2, lines 40-48); Nagata's working electrode is maintained at a set potential from the counter electrode (col. 3, lines 13-27).
- Dempsey's thermal, chemical and electrical characteristics for its sensing and reference electrodes are as similar as possible (col. 4, lines 11-21); Nagata's working electrode is a Pt electrode and its reference electrode is an Ag electrode (col. 5, lines 11-17).
- Dempsey's reference electrode is exposed to the uncontaminated atmosphere, i.e., to the atmosphere without the gaseous constituent being measured; Nagata's reference electrode is exposed to the same constituents as the working and counter electrodes.
- Dempsey's sensing electrode is the only electrode exposed to the gas constituent being measured (see Fig. 1); Nagata's working, counter and reference electrodes are all exposed to the gas constituent being measure (see Figs. 1 and 2, gas-permeable film 5).

- Dempsey discloses a hydrated gas sensor for operation from 1°C to 40°C; Nagata discloses a flammable gas sensor for operation from 100°C to 400°C.

Thus, it can be seen that Dempsey's reference electrode performs a completely different function than that of Nagata's reference electrode. Dempsey's reference electrode, which is as similar as possible to the sensing electrode and positioned as close as possible to the sensing electrode, and which is exposed to the atmosphere without the contaminating gas, is used, at least in part, to provide temperature stability during "zero-air" operation. In contrast, Nagata's reference electrode, which is not similar to the working electrode and which is exposed to the same contaminated atmosphere as the working electrode, is not used to provide temperature stability during "zero-air" operation. As the three-electrode sensor of Nagata so significantly differs in its construction and operation from the three-electrode sensor of Dempsey, there is no predictability or reasonable expectation of success that Nagata's teachings concerning three- and two-electrode sensors could be applied to Dempsey's three-electrode sensor.

As to the Examiner's contention that Dempsey's reference electrode is the source of the temperature variation problem, Applicants disagree and maintain their arguments as presented in the previously filed responses. Further, Applicants submit that there is no disclosure in Dempsey that the reference electrode is the source of the "background current" that Dempsey wants to eliminate—rather, it appears that the effect of temperature variation on the sensing electrode relative to the counter electrode causes the undesirable background current.

As the Examiner has recognized that Dempsey fails to disclose that the sensing electrode and the counter electrode are the only two electrodes, and as Nagata, as discussed above, fails to disclose that the reference electrode of Dempsey could be eliminated without disrupting the principle of operation of Dempsey, the combination of Dempsey in view of Nagata fails to render claims 79, 81, 86, 88 and 97 unpatentable. Further, as none of Vanderborgh, Uchida or Grot discloses two-electrode gas sensors, Vanderborgh, Uchida and Grot fail to cure the deficiency of Dempsey in view of Nagata.

Claims 81 and 88

Claim 81 and 88 additionally recite that the sensing electrode reacts with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode “*in the absence of an applied voltage to the sensing electrode.*” In contrast, Dempsey particularly discloses that the sensing electrode is maintained at a potential (col. 2, lines 40-62). Nagata also discloses that the working electrode has an applied voltage (see item 9 in Fig. 8 and col. 7, line 66 – col. 8, line 5). Thus, the combination of Dempsey in view of Nagata and Vanderborgh, Uchida or Grot fails to disclose the “absence of an applied voltage to the sensing electrode.”

Claim 97

Claim 97 additionally recites that the sensing and the counter electrodes are approximately 15 mm in diameter. Nagata discloses that the two-electrode sensor is only feasible if the “counter electrode is larger in area than the working electrode by a factor of a two-figure number or more ....” In other words, Nagata expressly teaches away from the interchangeability of three-electrodes and two-electrodes when the electrode areas are of the same order of magnitude. Thus, the combination of Dempsey in view of Nagata and Vanderborgh, Uchida or Grot fails to disclose each and every element of this claim.

Further, claim 97 recites that the solid, perfluorinated, ion-exchange membrane is approximately 0.17 mm thick. In Example 4, Dempsey discloses that the membrane may be 0.3 mm thick (see col. 11, line 56 to col. 12, line 35 and Table I). With this membrane thickness and a 1 mm spacing between the sensing and the reference electrodes, Dempsey discloses that the resistance ratio of the sensing-to-reference electrodes and the sensing-to-counter electrodes is between 50-210 (see Table I). Dempsey discloses that this resistance ratio range is important (see Abstract, claims 4-9 and col. 6, lines 20-37). Ignoring Dempsey’s disclosure regarding acceptable resistance ratios, the Examiner erroneously asserts that it would have been obvious “to utilize a thinner membrane than that set forth by Dempsey in order to further reduce the internal resistance of the sensor” (OA, p. 7). Applicants disagree. As the membrane thickness of 0.3 mm already provides the desired resistance ratios (see Table I), Applicants respectfully submit that a membrane thickness of 0.17 mm would lie outside the desired range taught by Dempsey (at least for five of the six cells (cells A-E) listed in Table I). In other words, there is no expectation that utilizing a

thinner membrane and thereby, presumably, reducing the resistance between the sensing and counter electrodes would be beneficial or successful.

For all the above reasons, the subject claims are patentable over the applied citations.

*ii. Claims 17, 79-101, 103-106, 108, 110 and 112-113*

Claims 17, 79-101, 103-106, 108, 110 and 112-113 stand rejected over Tomantschger et al. (US 5,173,166) in view of Dempsey and any of Vanderborgh, Uchida and/or Grot. Applicants traverse these rejections as follows.

The Examiner has recognized that Dempsey fails to disclose a porous mixed ionic-electronic conductive sensing electrode and/or a porous mixed ionic-electronic conductive counter electrode. As an initial matter, as discussed above, Uchida and Vanderborgh do not disclose the claimed electrode composition; Dempsey teaches away from using a non-hydrophobic electrode as taught by Grot; and combining Grot with Dempsey would render Dempsey inoperable. Tomantschger '166 fails to cure these deficiencies.

In fact, the Examiner has recognized that Tomantschger '166 fails to disclose a porous mixed ionic-electronic conductive sensing electrode and/or a porous mixed ionic-electronic conductive counter electrode. However, the Examiner has indicated that it would be obvious to use the teachings of Grot (or Vanderborgh and/or Uchida) for the electrodes of Tomantschger '166. Applicants disagree.

It is improper to attempt to replace Tomantschger's hydrophobic electrodes with the non-hydrophobic electrodes of Grot:

Applicants submit that it is improper to attempt to combine Tomantschger '166 with Grot (as discussed above, Uchida and Vanderborgh are not relevant). Specifically, Grot discloses a non-hydrophobic electrode (see Surampudi and discussion above), while Tomantschger '166 repeatedly and expressly teaches the use of hydrophobic electrodes. Tomantschger, in essence, teaches away from using non-hydrophobic electrodes.

Tomantschger '166 teaches away from using non-hydrophobic electrodes because Tomantschger is concerned with preventing electrolyte leakage, and non-hydrophobic electrodes would allow the electrolyte to leak. For example, in the Background section,

Tomantschger '166 discusses the problem of electrolyte leakage and the failings of the prior art:

"LaCONTI 4,025,412 ... the structure is susceptible to electrolyte leakage."

(Col. 3, lines 7-14.)

"KITZELMANN et al, 4,394,239 ... however such metals are hydrophilic, which may result in electrolyte loss." (Col. 3, lines 31-32.)

Tomantschger '166 solves this problem of electrolyte leakage, at least in part, by using gas porous, but liquid impermeable, i.e., hydrophobic electrodes, so as to preclude electrolyte loss. For example, with respect to its inventive electrodes, Tomantschger '166 discloses:

"The porous electrode may comprise a porous base layer, a catalytically active metal ..., carbon, and a *polymeric hydrophobic binder*."

(Abstract, emphasis added.)

"Still further, the present invention provides porous electrodes which may comprise at least one porous layer containing a catalytically active metal—usually a noble metal—carbon, and a *polymeric hydrophobic binder*."

(Col. 5, lines 23-27, emphasis added.)

"The catalyst may be a catalytically active noble metal ... *all with a suitable polymeric hydrophobic binder*."

(Col. 6, lines 28-33, emphasis added.)

"The porous electrodes having a PTFE structure with carbon are particularly useful in the present invention. ... At the same time, because of the *hydrophobicity of the PTFE, electrolyte leakage is precluded*."

(Col. 10, lines 36-43, emphasis added.)

"[C]arbon filled gas permeable paper or cloth may be dipped into PTFE ... Then the components of the electrochemical cell are place in an assembly jig .... In that instance, the conductive plastic plates heat up and melt into the two electrode structures, *producing a conductive and liquid tight bond*."

(Col. 10, lines 54-62, emphasis added.)

"In keeping with the invention, the porous sensing electrodes used in the electrochemical sensing cells discussed above comprise a layer which contains a catalytically active metal—usually a noble metal—together with carbon and a *polymeric hydrophobic binder*, all in a suitable substrate."

(Col. 11, lines 26-31, emphasis added.)

"The polymeric binder may be any suitable inert resin, *particularly a hydrophobic component*. Examples of such binders include polyethylene, polypropylene, polyvinylchloride, polystyrene, and PTFE ...."

(Col. 11, lines 26-53, emphasis added.)

Thus, Tomantschger '166 repeatedly and expressly teaches that its electrodes are formed with a polymeric binder that is hydrophobic so as to preclude leakage of the electrolyte. In fact, each of the five examples of the composition of typical electrodes in the table of column 12 include a backing layer with 50% PTFE (a hydrophobic polymeric binder) and an active layer with from 11% to 50% PTFE.

Even further, Tomantschger '166 teaches away from using non-hydrophobic electrodes because Tomantschger discloses gas sensing electrodes, *i.e.*, gas permeable electrodes, in contact with liquid electrolyte or liquid water. Were the gas sensing electrodes of Tomantschger '166 to be non-hydrophobic, the electrodes would be flooded by the liquid electrolyte/water and would thereby be rendered inoperative. In other words, Tomantschger '166 is only operative if the gas sensing electrodes are hydrophobic, such that flooding of the electrodes by the liquid electrolyte/water is prevented.

Thus, Applicants submit that it is improper for the Examiner to conclude that the non-hydrophobic electrodes of Grot could simply be substituted into the sensor of Tomantschger '166. First, the use of the non-hydrophobic electrodes as taught by Grot is at odds with the express teachings of Tomantschger '166 regarding its use of hydrophobic electrodes to preclude electrolyte leakage. Further, the use of the non-hydrophobic electrodes as taught by Grot in the sensor of Tomantschger '166 would render Tomantschger's gas sensor inoperative due to flooding of the electrodes by the liquid electrolyte/water.

Further, there is no motivation to combine Grot with Tomantschger '166. Grot's rationale for its inventive electrode ink is to improve the *bonding* between the membrane and the electrode:

The contact of the gas-liquid permeable porous electrode with the ion exchange membrane is an important factor for the efficiency of the M & E cell. When the thickness of an electrode is nonuniform or the contact between the electrode with the ion exchange membrane is not satisfactory, a part of the electrode is easily peeled off adversely effecting the electrical

properties of the cell. The advantages of the M & E structure are then decreased or lost. (Col. 1, lines 31-39.)

The ink readily adheres to the membrane thereby reducing the likelihood of delamination of the electrode structure, uniform application of the electrode layer, reduction in the formation of gas bubbles at the membrane/electrode interface and without adversely effecting (sic) the strength, dimensional stability or electrical properties of the membrane. (Col. 4, lines 17-24.)

On the other hand, Applicants submit that Tomantschger '166 fails to disclose that its electrodes are bonded to the electrolyte. Rather, Tomantschger '166 teaches that the electrodes are mounted in the first and second side frames and placed against the frame forming the electrolyte chamber (col. 9, lines 53-55; col. 10, lines 1-13; Fig. 1). A disclosure that the electrodes are "mounted against the frame" that holds the electrolyte is not a disclosure that the electrodes are bonded to the electrolyte. As Tomantschger '166 fails to disclose bonding the electrodes to the electrolyte, one would not be motivated to use Grot's electrode ink to improve this non-existent bond.

And indeed, Applicants submit that the Examiner's rationale for combining Grot with Tomantschger '166 ("to increase the electrode efficiency and reduce its resistance") lacks the support of any reasoned explanation. There is no disclosure in Grot that the electrode ink of Grot "increases the electrode efficiency or reduces its resistance." Rather, at most, Grot discloses the advantages of its electrode ink as:

"Therefore, an electrode ink is needed which may be efficiently, inexpensively, and reproducibly applied to an ion exchange membrane, so as to form a uniform electrode structure which uses a relatively small loading of catalyst does not crack or deform during operation, does not adversely decrease ionic conductivity of the structure, does not effect (sic, affect) the strength of the structure and does not adversely interact with the ion exchange polymer contained in the membrane." (Col. 3, lines 49-57.)

In other words, Grot's advantages are directed to its improved bonding (which is inapplicable with respect to Tomantschger '166), while not adversely impacting other properties. Grot fails to disclose that, absent improved bonding, its electrode ink "increases the electrode efficiency and reduces its resistance."

It is improper to assume that Dempsey's electrode and membrane dimensions are applicable to Tomantschger's sensor:

As recognized by the Examiner, Tomantschger '166 does not explicitly disclose a particular diameter for its electrodes or a particular thickness of electrolyte. The Examiner relies on Dempsey for its disclosure of sensing and counter electrodes having a diameter of 16 mm and a Nafion® membrane thickness of 0.3 mm. The Examiner asserts that it would have been obvious to use the electrode and electrolyte dimensions of Dempsey for the dimensions of Tomantschger '166. Applicants disagree.

The absence of any disclosure in Tomantschger '166 as to electrode diameters does not lead one to conclude that *any* dimensions could be utilized. This is particularly the case when considering the claims directed to two-electrode electrochemical gas sensors. In fact, Nagata, cited by the Examiner and discussed above, explicitly discloses that the dimension of a counter electrode for a three-electrode sensor (*e.g.*, Nagata, FIG. 1) is different than the dimension of a counter electrode for a two-electrode sensor (Nagata, FIG. 8).

For example, Nagata discloses that when a reference electrode is eliminated from a three-electrode sensor, for certain functionalities and under certain operating conditions, commensurate performance of the three-electrode sensor may be achieved if the area of the counter electrode in the two-electrode sensor is ten or more times (and preferably 100 times) as large as the sensing electrode.

Thus, at the very least, Nagata teaches that Dempsey's disclosure as to dimensions of components of a three-electrode sensor does not provide any teachings, and is thus irrelevant, as to any dimensions of components of a two-electrode sensor, such as disclosed by Tomantschger '166.

As it is improper to combine Tomantschger '166 with Vanderborgh, Uchida or Grot, with respect to the composition of the electrodes, and as it is further improper to combine Tomantschger '166 with Dempsey with respect to the dimensions of the sensor components, claims 17, 79-101, 103-106, 108, 110 and 112-113 are not rendered unpatentable over the asserted combination of references.

iii. *Claims 17, 80, 82, 84, 87, 89, 91, 92, 95, 96, 98-101, 103, 104, 108, 110 and 112-113*

Claims 17, 80, 82, 84, 87, 89, 91, 92, 95, 96, 98-101, 103, 104, 108, 110 and 112-113 stand rejected over Dempsey in view of any of Vanderborgh, Uchida and/or Grot.

As presented above (see infra pp.41-42), Applicants submit that a person of ordinary skill the art would realize that replacing Dempsey's gas-diffusion type, hydrophobic electrodes with a liquid-fuel type electrode as taught by Grot (Uchida and Vanderborgh not being relevant) would result in the electrodes being flooded/drowned with the distilled water, such that the gas to be reacted would be unable to reach the reaction sites within the electrodes. (See discussion of Surampudi, above.) In essence, the electrodes would be flooded and Dempsey's gas sensor would be unable to sense or react to the gas. Thus, contrary to the Examiner's assertion, as the combination renders Dempsey's sensor inoperable, one of ordinary skill in the art would have reason to NOT replace the hydrophobic electrodes of Dempsey with the non-hydrophobic electrodes of Grot.

Further, claim 80 includes the recitation of "the sensing electrode reacting with the gas to produce a change in an electrical characteristic between the sensing electrode and the counter electrode in the absence of an applied voltage to the sensing electrode." Claims 84, 87, 91 and 94 include similar recitations. Claim 92 recites "in the absence of any biasing voltage."

The Examiner has indicated that the electrode of Dempsey in view of Vanderborgh, Uchida and/or Grot would inherently be capable of reacting with a gas in the absence of an applied voltage to the sensing electrode. Applicants traverse these rejections as follows.

A finding of inherency requires that the missing descriptive matter is necessarily present. Inherency may not be established by probabilities or possibilities. The mere fact that a certain thing may result is not sufficient. MPEP 2112(IV). Further, in relying upon the theory of inherency, the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic necessarily flows from the teachings of the prior art. *Id.* Applicants submit that the Examiner has not provided such a basis. Nor is any reason apparent to Applicant as to why Dempsey in view of the secondary citations could necessarily be capable of reacting with a

gas in the absence of an applied charge to the sensing electrode. Furthermore, as to obviousness, obviousness cannot be predicated on what is not known at the time the invention was made, even if the inherency of a certain feature is later established. MPEP 2141.02(V).

Indeed, Dempsey expressly teaches that “the voltage [of the sensing electrode] should not be allowed to fall below approximately 1.0 volts in order to maintain an oxide coating on the surface of the catalytic sensing electrode to prevent CO poisoning of the electrode and to prevent reduction of oxygen at the electrode or other competing reactions which introduce error currents.” Col. 10, lines 3-9. In other words, *Dempsey expressly teaches that its sensor electrode would be poisoned by CO in the absence of a maintained voltage of 1.0 or greater.* In light of this express teaching and in the absence of any teaching as to why the electrodes of Grot (Uchida and Vanderborgh not being relevant) would not be poisoned by CO, it appears that the electrode of Dempsey in view of Grot would not inherently be capable or reacting with a gas in the absence of an applied voltage to the sensing electrode.

Accordingly, Applicants submit that claims 17, 80, 82 84, 87, 89, 91, 92, 95, 96, 98-101, 103, 104, 108, 110 and 112-113 are not rendered unpatentable over the asserted combination of references.

Claims 82 and 89 further include the recitation that “the sensing electrode and the counter electrode [are] on opposite sides of the first protonic conductive electrolyte member.” For at least the reason that the combination of Grot with Dempsey would render Dempsey’s sensor inoperable, such that one of ordinary skill in the art would have reason to NOT replace the hydrophobic electrodes of Dempsey with the non-hydrophobic electrodes of Grot, Applicants submit that claims 82 and 89 are also allowable. Claims 98-101, 103, 104, 108, 110 and 112-113 and amended claims 2, 17, 18 and 27 depend directly or indirectly from claim 82 and contain additional recitations thereto. Thus, Applicants respectfully submit that these claims are also patentably distinguishable from the cited references.

**iv.      *Claims 83, 85, 90, 93 and 94***

Claims 83, 85, 90, 93 and 94 stand rejected over Dempsey in view of any of Vanderborgh, Uchida and/or Grot and further in view of Nagata.

As an initial matter, as discussed above, Dempsey teaches away from using an electrode as taught by Grot (or Uchida, or Vanderborgh), and further combining Grot (or Uchida, or Vanderborgh) with Dempsey would render Dempsey inoperable. Nagata fails to cure these deficiencies.

The Examiner has asserted that it would have been obvious to utilize only two electrodes for the sensor of Dempsey as taught by Nagata. Applicants disagree, and as presented above, have shown that the teachings of Nagata concerning any substitution of a two-electrode sensor for a three-electrode sensor are not applicable to the three-electrode temperature-stabilized sensor of Dempsey.

Accordingly, Applicants submit that claims 83, 85, 90, 93 and 94 are not rendered unpatentable over the asserted combination of references.

**v.      *Claim 102***

Claim 102 stands rejected over Dempsey in view of any of Vanderborgh, Uchida and/or Grot and further in view of Tomantschger '274 (US 5,302,274). Alternatively, claim 107 stands rejected over Tomantschger '166 in view of any of Vanderborgh, Uchida and/or Grot and further in view of Tomantschger '274.

As an initial matter, as discussed above, Dempsey teaches away from using an electrode as taught by Grot (Uchida and Vanderborgh being irrelevant), and further combining Grot with Dempsey would render Dempsey inoperable. Additionally, Tomantschger '166 also teaches away from using a non-hydrophobic electrode as taught by Grot. Tomantschger '274 fails to cure these deficiencies.

Accordingly, Applicants submit that claim 102 is not rendered unpatentable over the asserted combinations of references.

**vi.      *Claims 105 and 106***

Claims 105 and 106 stand rejected over Dempsey in view of any of Vanderborgh, Uchida and/or Grot and further in view of LaConti (US 4,820,386).

As an initial matter, as discussed above, Dempsey teaches away from using an electrode as taught by Grot (Uchida and Vanderborgh being irrelevant), and further combining Grot with Dempsey would render Dempsey inoperable. LaConti fails to cure these deficiencies.

Accordingly, Applicants submit that claims 105 and 106 are not rendered unpatentable over the asserted combination of references.

**vii.     *Claim 107***

Claim 107 stands rejected over Dempsey in view of any of Vanderborgh, Uchida and/or Grot and further in view of Razaq (US 5,322,602). Alternatively, claim 107 stands rejected over Tomantschger '166 in view of any of Vanderborgh, Uchida and/or Grot and further in view of Razaq.

As an initial matter, as discussed above, Dempsey teaches away from using an electrode as taught by Grot (Uchida and Vanderborgh being irrelevant), and further combining Grot with Dempsey would render Dempsey inoperable. Additionally, Tomantschger '166 also teaches away from using an electrode as taught by Grot. Razaq fails to cure these deficiencies.

Accordingly, Applicants submit that claim 107 is not rendered unpatentable over the asserted combinations of references.

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VII. Conclusion

Each of claims presented herein is directed to subject matter that was originally disclosed. Applicants respectfully request consideration and allowance of all the claims.

Respectfully submitted,

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